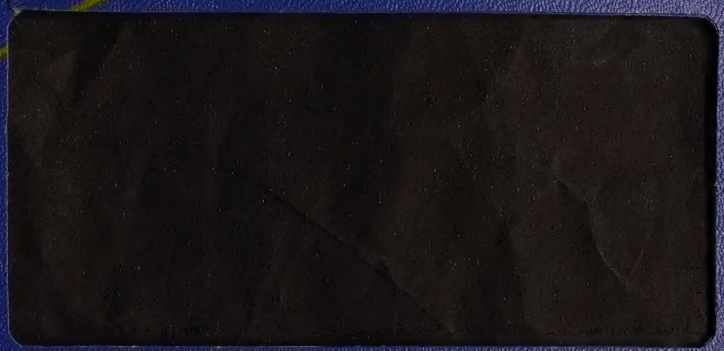

PDF

AVCO SM-005-2
Shock Test Machine

AVCO

TECHNICAL MANUAL

RAD-PM-STM35-3

Installation, Operation, and Maintenance

Instructions

660-1085

for the

SHOCK TEST MACHINE

Type SM-005-2

15 June 1962

RESEARCH AND ADVANCED DEVELOPMENT DIVISION
AVCO CORPORATION
WILMINGTON, MASSACHUSETTS

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SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION.

1-2. This manual contains installation, operating, and maintenance instructions for the Shock Test Machine, Type SM-005-2 designed and produced by the Research and Advanced Development Division of Avco Corporation, Wilmington, Massachusetts. The shock test machine is a pneumatically controlled and actuated device designed to produce a variety of shock pulses up to 10,000 times the force of gravity and rated for specimen loads up to 30 pounds. It is capable of reproducing shocks encountered during the operation of jet aircraft and missiles together with the resulting high-acceleration transient vibration. The machine also has the capability of reproducing normal shocks encountered in material handling and shipping. In addition, the machine may be used for production testing.

1-3. DESCRIPTION.

1-4. GENERAL. The Type SM-005-2 Shock Test Machine (figures 1-1 and 1-2) is composed of six major assemblies: a carriage, brake, control panel, pneumatic cylinder, plate assembly, and base. This shock machine does not depend upon gravity to obtain the desired terminal velocity; therefore, the changeover from one shock pulse level to another can be rapidly accomplished by a simple adjustment of air pressure.

1-5. BASE WELDMENT. The base weldment consists of a 1-inch steel plate 20 inches square, welded to two channels 18 inches long. A steel tube approximately 28 inches long with a 6.50-inch outer diameter (OD) is welded to the steel plate. Welded to the other end of the tube is a steel top plate, 3 inches thick. Twenty-two 3/8-inch steel bars of varied lengths are welded at specified intervals around the circumference of the steel tube and flange of the top plate. Two 2-inch OD steel tubes approximately 4 inches long are welded to the large tube just below the top plate. The base assembly, besides providing support for the unit, also serves as a housing for the pneumatic cylinder and brake assemblies.

1-6. PNEUMATIC CYLINDER. The pneumatic cylinder assembly (figure 1-2) consists of a brass cylinder approximately 22 inches long with a 3-inch bore containing a double-acting piston and piston rod.

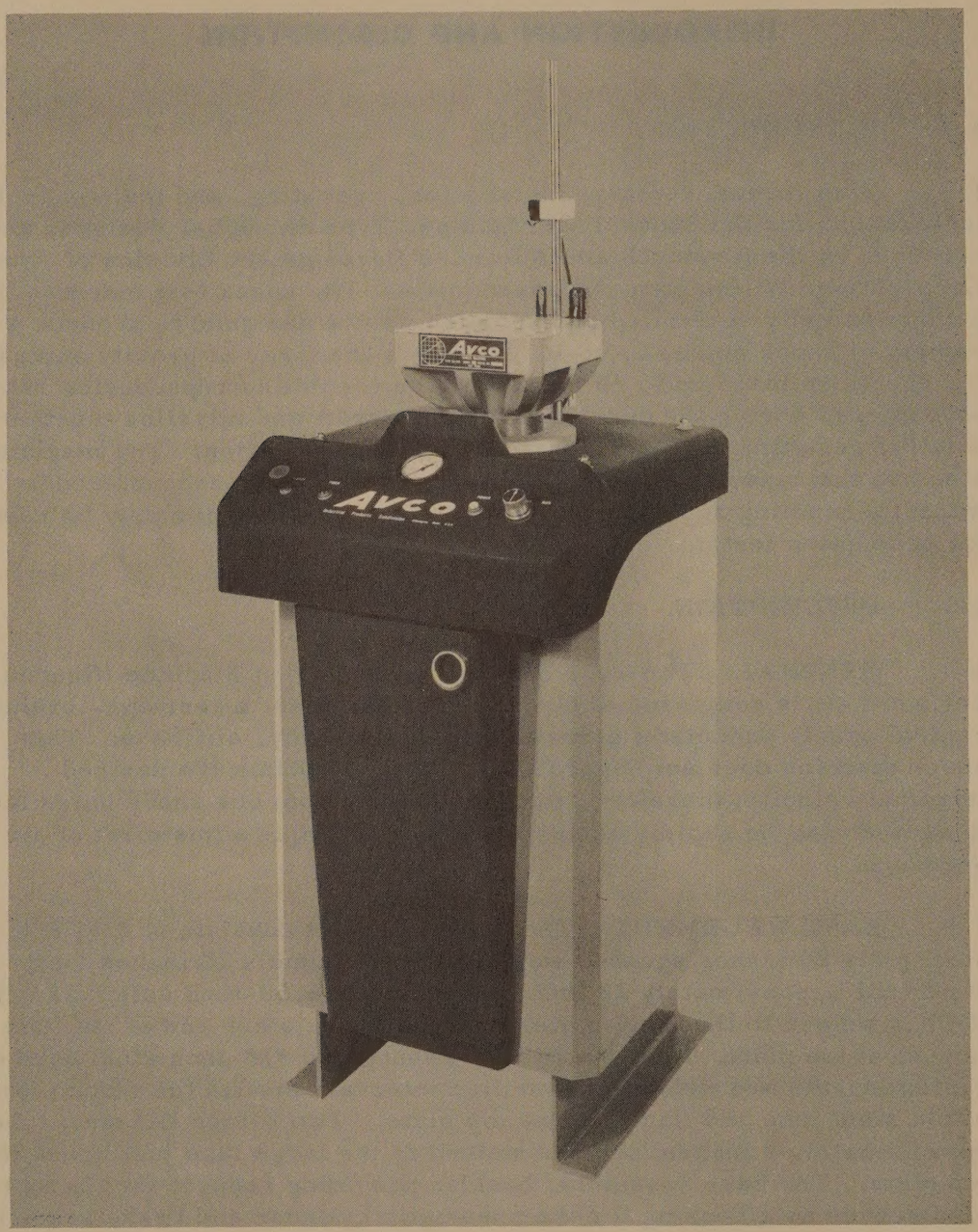

Figure 1-1. Shock Test Machine, Type SM-005-2

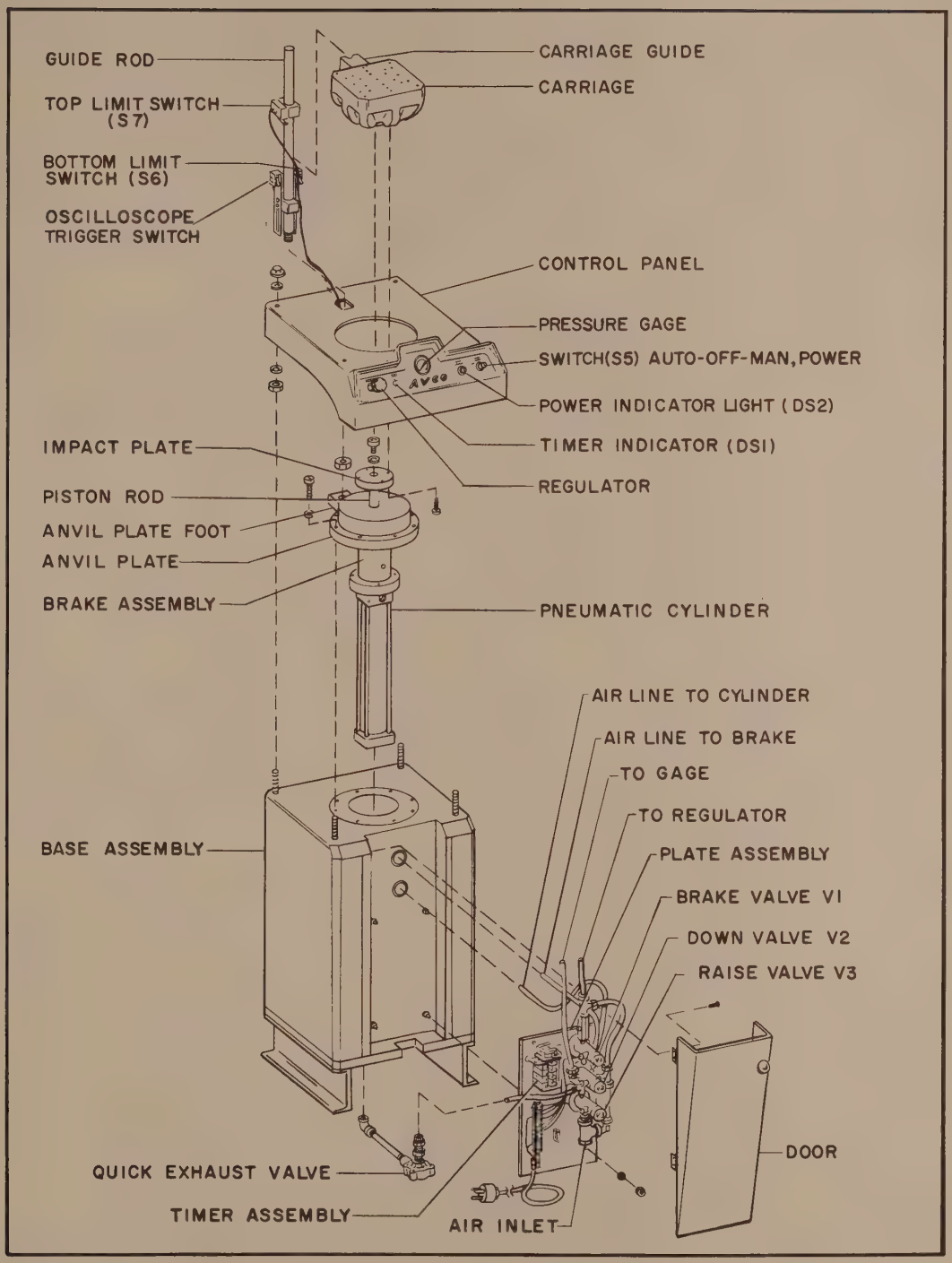

Figure 1-2. Exploded View of Shock Test Machine

The cylinder contains a threaded hole in the bottom and one near the top just below the upper flange, to permit the introduction of air into and/or release of air from the cylinder for the purpose of actuation.

1-7. BRAKE ASSEMBLY. The brake assembly (figure 1-2) consists of a brake housing and core. The brake housing is constructed of a steel pipe flanged at both ends. The core is a rubber tube bonded to an aluminum cap at each end. The brake assembly performs the dual purpose of holding and releasing the carriage.

1-8. CARRIAGE. The carriage (figure 1-2) is a ribbed aluminum casting weighing approximately 30 pounds, on whose upper surface are a number of tapped mounting holes. These tapped holes are used for securing the components to be tested. The pattern (figure 1-3) of these mounting holes consists of four concentric circles with 6, 8, 6, and 4 holes respectively.

1-9. CONTROL PANEL. The control panel (figure 1-2) is of molded fiberglass construction. The panel contains a pressure regulator for air pressure control, timer motor indicator lamp, pressure gage, power indicator lamp, and a combination 3-position rotary pushbutton switch.

1-10. PLATE ASSEMBLY. The plate assembly (figure 1-2) contains a timer assembly, fuze holder, terminal board assembly, three solenoid operated air valves, an air pressure check valve and an orifice nipple to control the upward velocity of the carriage during the raise cycle.

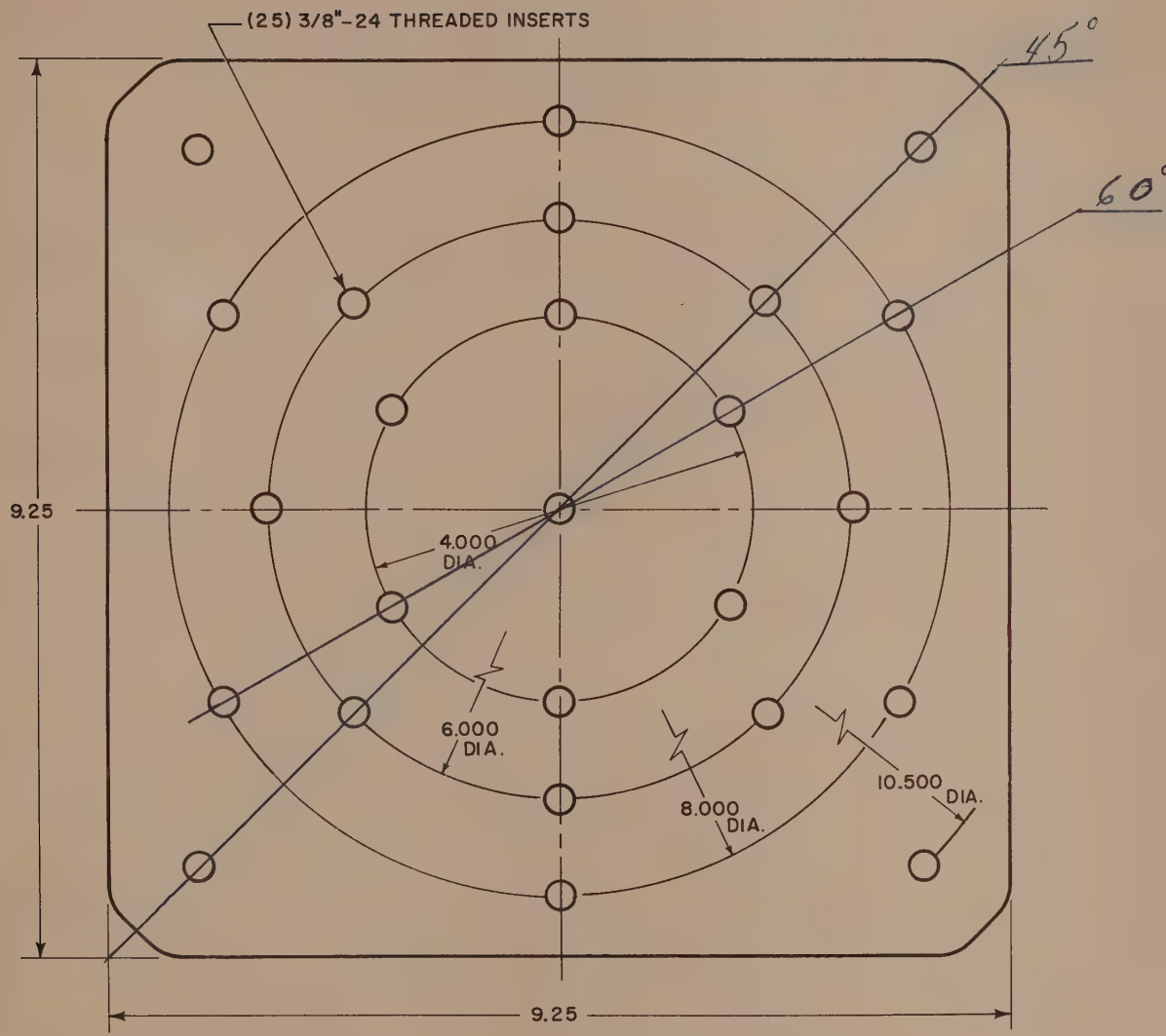

Figure 1-3. Carriage Mounting Hole Pattern

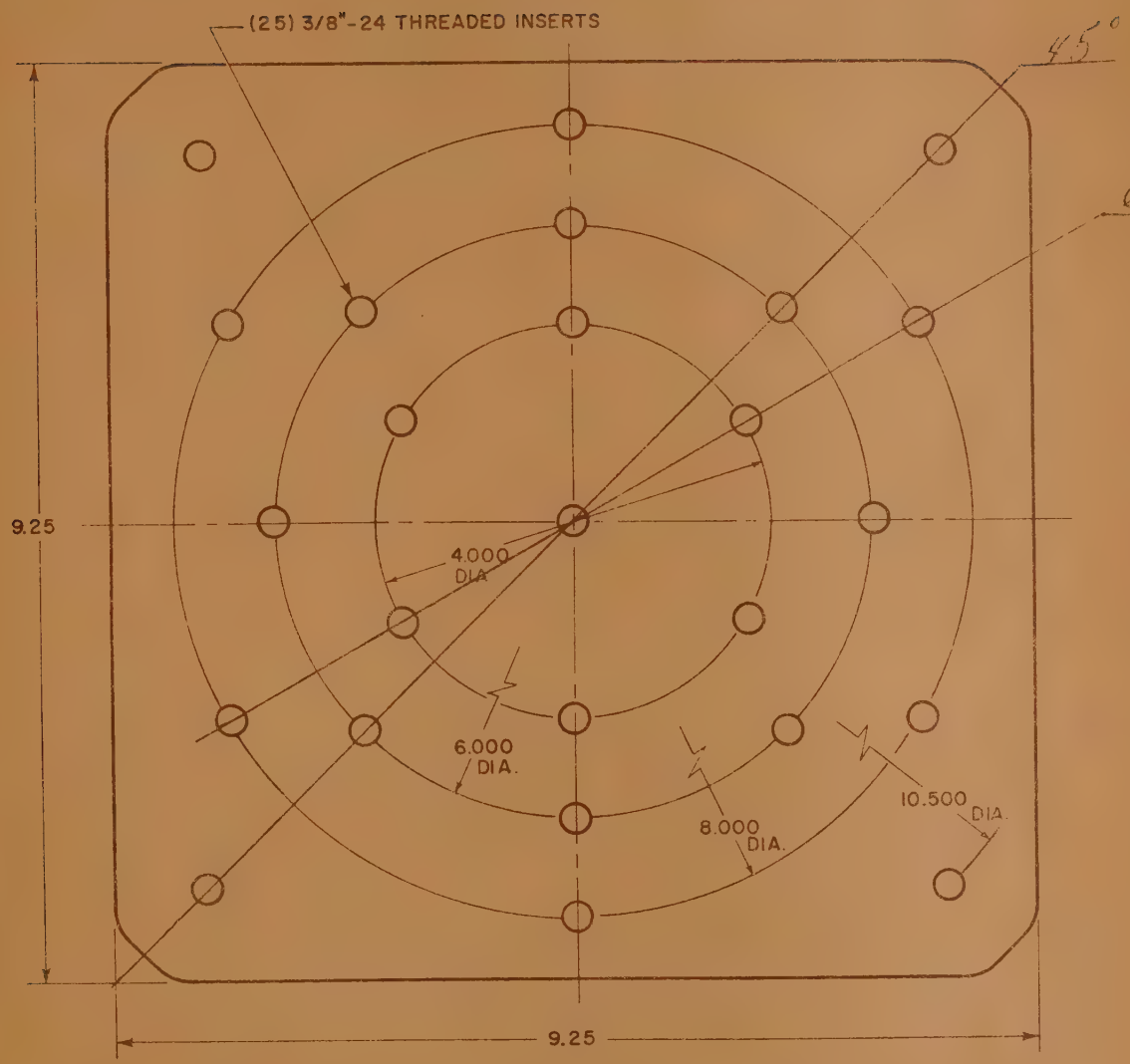

Figure 1-3. Carriage Mounting Hole Pattern

SECTION II

SPECIFICATIONS

Type	SM-005-2
Machine Dimensions	
Base	20 inches x 20 inches
Height (floor to top of carriage)	43 inches
Installed Weight	1,200 lb
Shipping Weight	1,250 lb domestic 1,340 lb export
Carriage Mounting Bolt Pattern	Twenty-five 3/8-24 threaded helical steel inserts, including MB C-10 shaker pattern
Carriage Size	9-1/4 inches x 9-1/4 inches
Drop Height	8 inches (max)
Specimen Weight	30 lb (max)
Specimen Height	Unlimited due to design of machine
Power Source	117 vac, single phase, 60 cps
Air Pressure	90 to 100 psi

SECTION III

OPERATING INSTRUCTIONS AND TEST EQUIPMENT SETUP PROCEDURES

3-1. GENERAL.

3-2. The Avco Type SM-005-2 Shock Test Machine is designed for a single (manual) and/or repetitive (automatic) operation. When the POWER selector switch is placed in the MAN position, the machine completes a single cycle of operation (raising and dropping of the carriage). When the POWER selector switch is set in the AUTO position, the machine automatically repeats the cycle until shut off.

3-3. OPERATING PROCEDURES.

3-4. For a single (manual) and/or repetitive (automatic) operation of the test machine proceed as follows:

NOTE

When using the shock test machine for the first time, rotate the knob at the bottom of the timer motor cam shaft, until the wheel of cam switch S4 falls into the cutout of its cam.

a. Turn POWER selector switch to OFF position.

b. Rotate the air pressure REGULATOR knob completely counterclockwise (to decrease air pressure to 0 psi).

c. Connect the electrical power cable to 117-volt, 60-cps power source.

d. Connect the air pressure line to the shock test machine.

CAUTION

Make certain the air source line contains a suitable air filter and regulator as required to limit pressure to 100 psi maximum. Do not use an automatic oiler in the air supply line to the machine.

e. Adjust the top limit switch on the guide rod for an 8-inch stroke, and secure with switch bracket thumbscrew.

f. Adjust the bottom limit and oscilloscope switch on the guide rod and secure with switch bracket thumbscrew. Refer to impact pad instruction sheet.

NOTE

To record shock pulses refer to paragraph 3-9 through 3-15, Setup Procedures for Recording Shock Pulses.

g. Secure the test specimen or a dummy load on the carriage.

CAUTION

Do not use test specimen load greater than 30 pounds.

h. Turn POWER selector switch to MAN position (POWER indicator light will illuminate).

i. Press the POWER selector switch pushbutton and hold for a few seconds until the timer motor starts and carriage starts to rise. Turn POWER selector switch to OFF position as soon as the carriage makes contact with the top limit switch (S7). The carriage will now stay in this position until the POWER selector switch is turned to either MAN or AUTO position.

NOTE

If an electrical power failure occurs while the carriage is in the raised position air flows through the normally open brake valve (V1), into the pneumatic brake at line pressure providing braking action. Since the other two valves V2 and V3, are normally closed, the air is exhausted from both ends of cylinder. If an air line ruptures, the check valve prevents air from exhausting from the brake valve (VI). As the timer

motor continues to operate, the electrical power will energize the solenoid of the brake valve (V1), and the carriage will fall free (from its own weight).

j. Place rubber impact pad or lead pellets on anvil. Refer to paragraphs 3-5 through 3-8.

k. Adjust air pressure REGULATOR knob until desired air pressure is indicated on pressure gage. Refer to impact pad instruction sheet for necessary air pressure setting. Regulator knob may be secured with nut beneath regulator knob.

CAUTION

Keep hands clear of anvil plate and carriage area. When the machine is put in MAN or AUTO operation, the carriage will automatically drop under pressure onto the impact pad or lead pellets.

l. To complete a single sequence of operation, reset the POWER selector switch in MAN position; the TIMER indicator light will stay illuminated and the carriage will automatically drop onto the impact device. At this point the TIMER indicator light will go out. To repeat another cycle when using a rubber pad simply depress pushbutton. When using lead pellets repeat step i and replace lead pellets.

m. For automatic operation place the POWER selector switch in its AUTO position. The machine will continue to raise and drop the carriage until machine is shut off.

n. The bottom limit switch (S6) may have to be adjusted if the carriage rebounds and restrikes the rubber pad after initial impact. The adjustment may be accomplished by loosening the two fillister head screws, item 54, on figure 7-4, and moving the switch and adjustment arm up approximately 1/4 inch. Restart the machine and note if the rebound is eliminated. Continue adjusting the bottom limit switch until the rebound is eliminated. The switch setting will remain constant for a specific pressure setting. In general, as the down pressure setting is increased, the bottom limit switch will have to be raised higher to eliminate the rebound.

o. The oscilloscope trigger switch can now be adjusted in the same procedure as the previous paragraph, until the shock pulse is centered on oscilloscope tube.

3-5. DECELERATION DEVICES.

3-6. When a single (manual) cycle is performed, either lead pellets or rubber impact pads may be used as deceleration devices. (Refer to paragraph 4-14 and 4-15, Deceleration Devices). When lead pellets are used, the carriage of the shock test machine must be raised as indicated in paragraph 3-4, steps h, i, and j and the lead pellets must be replaced to make the machine ready for the next test. When rubber impact pads are used, the machine is always ready for the next test. When repetitive (automatic) testing is performed, only rubber impact pads can be used.

3-7. INSTALLATION OF IMPACT PAD.

3-8. The impact pad set usually consists of a single split rubber impact pad. The pad bolted to the top of the shock machine anvil plate. Four 1/4-20 UNC x 3/4 socket-head capscrews are provided with the pad set for attaching the pad and plate. These capscrews should be torqued to 75 in.-lb. Care should be taken to see that the metal base of the pad fits flat against the anvil plate. Remove any dirt, burrs, or chips.

NOTE

Some impact pad sets consist of two split rubber pads or single pad and a crowned impact plate. For these special pad sets one split pad is bolted to the anvil plate and the other pad or plate is fastened to the bottom of the impact plate located under the carriage. Pad sets that are designed for low terminal velocities, also require the use of an orifice plug. This plug is inserted in the exhaust port of the Quick Exhaust Valve (Item 17, figure 7-1). This plug provides a restriction to the air flow out of the cylinder as the carriage drops and allows for very accurate control of the terminal velocity. Detailed

instructions and orifice plugs (if required) are supplied with each impact pad set.

3-9. SETUP PROCEDURES FOR RECORDING SHOCK PULSES. (See figure 3-1.)

3-10. INSTRUMENTATION REQUIRED. The following instruments are recommended for use with the Type SM-005-2 Avco Shock Test Machine to record various shock pulses:

a. Accelerometer - Columbia Model 300, Endevco Model 2215 or equivalent (having approximately 5000 to 7000 micromicrofarads capacitance).

b. Cathode Follower - Columbia Model 4000 or equivalent (input impedance approximately 4000 megohms).

NOTE

It is important to have a cathode follower that will accept the highest anticipated voltage signal from the accelerometer. For instance, if the accelerometer has a nominal sensitivity of 25 millivolts peak/peak g and a 500 g peak shock pulse is generated, then the output voltage of the accelerometer would be 12.5 volts. Therefore, the cathode follower must have the ability to accept this voltage signal without cutting off or distorting the signal.

c. Oscilloscope - Tektronix Model 545 or equivalent with built in single sweep trigger circuit.

d. Polaroid Camera and Oscilloscope Adapter or equivalent.

e. Voltage Calibrator - Ballantine Model 301 or equivalent.

3-11. CONNECTING INSTRUMENTATION.

a. Connect oscilloscope to 117-volt, 60-cps source.

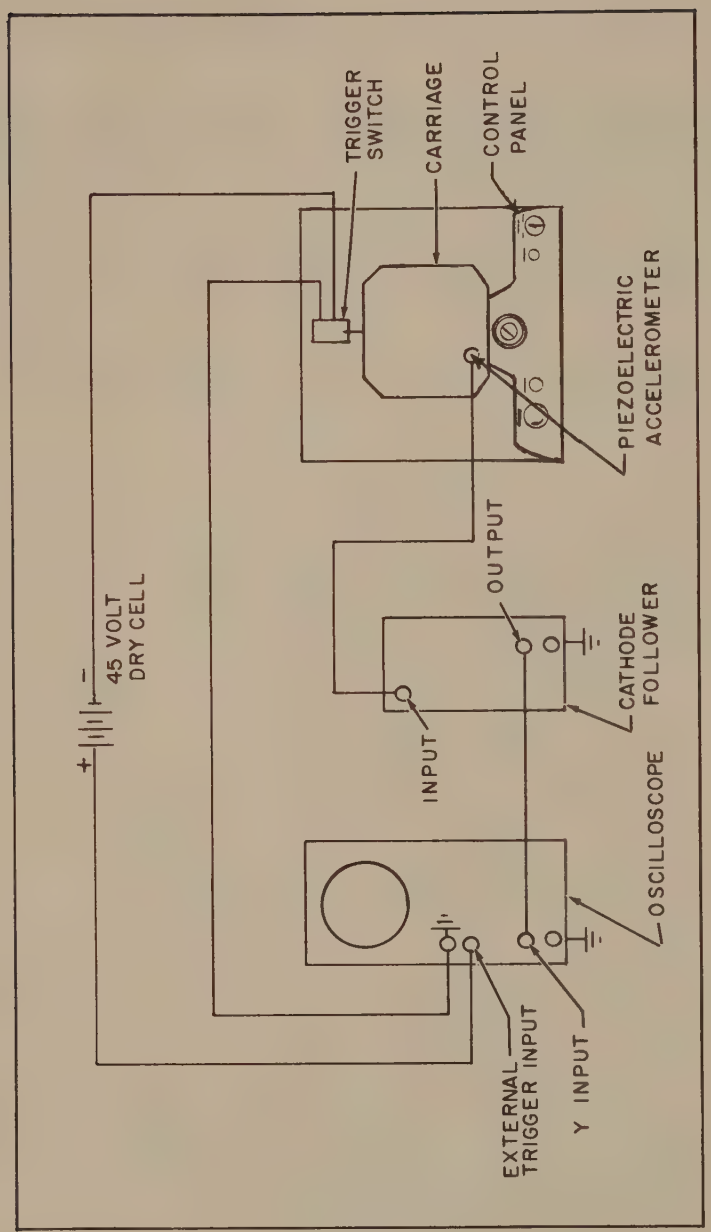

Figure 3-1. Typical Instrumentation Setup of Shock Test Machine, Type SM-005-2

b. Connect cathode follower to 117-volt, 60-cps source, as per manufacturer's manual.

c. Use a single shielded wire (Microdot cable or equivalent) to connect the accelerometer to the cathode follower with the shield serving as the ground conductor.

d. Connect a single shielded cable (microphone type) between the cathode follower and oscilloscope.

e. Connect a precision voltage calibrator to a 117-volt, 60-cps source.

f. Connect the calibrator to the cathode follower.

g. Set the calibrator for peak-to-peak output equal to the corrected accelerometer voltage output that is expected. Refer to paragraphs 3-16 through 3-19 to determine accelerometer output.

h. Connect 45 V battery in series with the oscilloscope.

The leads from the external triggering circuit with the 45-volt battery should be connected to the trigger switch located next to the bottom limit switch (S6). The positive side of the battery should be connected to the ungrounded lead as shown in figure 3-1.

3-12. OSCILLOSCOPE CALIBRATION. The calibration of a Tektronix oscilloscope, Model 545, with a type 53/54C preamplifier and a Polaroid camera with oscilloscope adapter is described herein. The calibration procedure is similar for oscilloscopes of other manufacturers.

3-13. Calibrate the pulse amplitude as follows:

a. Select either CHANNEL A or B.

b. Set CHANNEL switch at AC signal input.

c. Set HORIZONTAL DISPLAY switch to MAIN SWEEP NORMAL.

d. Set TRIGGERING MODE knob to AUTO.

e. Set TRIGGERING SLOPE knob to INT. + or -.

f. Turn MAIN SWEEP STABILITY knob clockwise until the calibration signal appears.

g. Set POLARITY switch of preamp to NORMAL.

h. Turn 5X MAGNIFIER knob to OFF.

i. Set Time/CM to 100 microsec and multiplier to 5.

j. Set VOLTS/CM knob to preamp to desired scale to produce a sine wave of optimum size for the test conditions to be met, i. e. 25 g/cm.

k. Use variable knob so the positive and negative peaks intersect convenient grid lines (see figure 3-2). Convenient grid lines are any combination that results in the maximum shock pulse amplitude that can be contained within the area of the oscilloscope face.

l. Photograph the calibration sine wave. This photograph is required as a basis for subsequent acceleration measurements.

3-14. POWERED DROP TEST SETUP. Secure the accelerometer (18 inch-pounds torque) to the carriage at any convenient location. An adapter stud is used to adapt the 3/8-24 thread in the mounting holes to the tapped hole in the accelerometer. Disconnect the calibrator from the cathode follower input and attach the cable from the accelerometer to the follower input. Reset the oscilloscope switches as follows:

a. Set HORIZONTAL DISPLAY switch to MAIN SWEEP NORMAL.

b. Set TRIGGERING MODE knob to D. C.

c. Set TRIGGERING SLOPE knob to EXT. +.

d. Set TIME/CM to 2 ms/cm (any time scale may be used to obtain a legible shock pattern) and a straight, horizontal line scan should appear on the face of the oscilloscope.

e. For convenience in interpreting the scan generated by a drop, adjust the position of the horizontal line so it is split by the 2nd grid line from bottom.

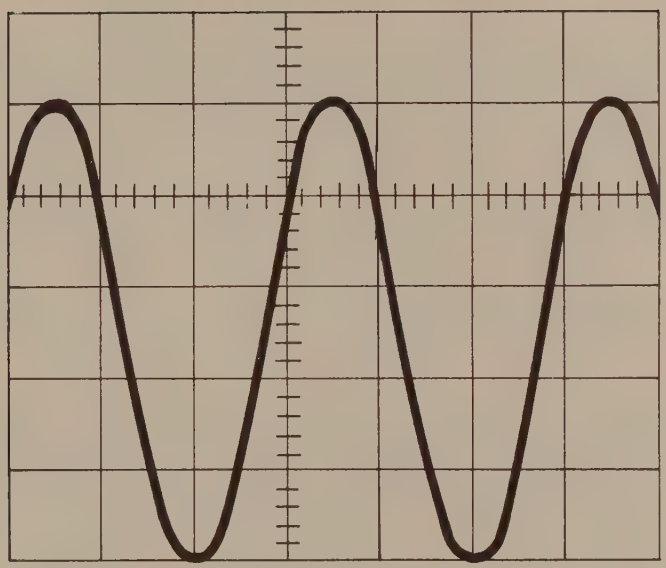

Figure 3-2. Proper Intersect of Positive and Negative Peaks

3-15. SINGLE SWEEP SETUP. Set up single sweep on oscilloscope as follows:

a. Turn STABILITY knob counterclockwise until sweep just disappears.

b. Connect the triggering switch cable to the oscilloscope with a .05 microfarad capacitor between the trigger input connection and a ground on the oscilloscope.

c. Press the SWEEP RESET button (the sweep READY light should go on).

d. With the STABILITY knob set where the sweep has just disappeared, manually operate the triggering switch and adjust the triggering level knob until the sweep appears every time the switch is depressed; some slight adjustment of the STABILITY knob may also be required.

e. Set HORIZONTAL DISPLAY switch to MAIN SWEEP DELAYED.

f. If ready light remains on, set the stability knob of delay sweep at 0.

g. Determine the weight of the test specimen and the fixture, and securely attach ballast of equal weight to the carriage for setup purposes. Lead is excellent ballast material because of its inherent damping qualities.

h. Operate the machine as described in paragraphs 3-3 and 3-5.

i. Adjust the height of the oscilloscope trigger switch (located on the shock machine) so that the pattern provides a complete and legible image. If the start of the pulse shape is too far to the left on the screen, the oscilloscope is being triggered too late, and the oscilloscope trigger switch should be raised slightly. When the sweep is too far to the right, lower the trigger switch.

j. Repeat as many drops as necessary using the ballast weight to refine the settings (drop height, type of deceleration device, oscilloscope sweep, pressure etc.) until the test requirements are met. Then remove the weight, install the fixture and test specimen, and conduct the test.

3-16. DETERMINING THE CORRECTED ACCELEROMETER OUTPUT.

3-17. When the Endevco model 2215 accelerometer is operated with approximately 300-uuf shunt capacity in the form of cables, connectors, and residual capacity of the cathode follower or the matching amplifier, the basic voltage sensitivity should be corrected.

3-18. Residual capacity of the Columbia Model 4000 cathode follower is approximately 27 uuf. The new sensitivity (E) can be determined from the following equation:

$$E = E_c \frac{(C_p + 100)}{(C_p + C_t)} \text{ rms mv/peak g}$$

Where

E_c = calibration sensitivity in rms mv/peak g (calibrated with 100 uuf total external capacitance loading),

E = actual sensitivity for any total external capacitive loading of C_t on the accelerometer,

C_p = accelerometer capacitance (uuf),

C_t = total external capacitance (of cable and cathode follower) in uuf.

For example:

E_c = 15.6 vms mv/peak g

C_p = 7000 uuf

C_t = 200 uuf cable
27 uuf residual amplifier capacity
227 uuf

$$E = 15.6 \times \frac{7000 + 100}{7000 + 227}$$

E = 15.3 rms mv/peak g.

3-19. To determine the voltage output of the accelerometer for a particular shock pulse, multiply the output per "g" by the expected shock amplitude and convert from rms volts to peak volts. For example, for a 100-g pulse:

$$E_{100g} = 15.3 \frac{\text{rms mv}}{\text{peak g}} \times 1.414 \frac{\text{peak volts}}{\text{rms volts}} \times 100 \text{ g}$$

$$= 2170 \text{ mv peak}$$

$$= 2.17 \text{ volts peak}$$

SECTION IV

PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. This section contains the theory of operation for the Shock Test Machine. It includes the distribution of electrical and pneumatic power during automatic and manual operation.

4-3. AUTOMATIC OPERATION.

4-4. RAISE CYCLE. To follow the operating sequence, it is suggested that the timer cam shaft be in the initial starting position, e. g., when the roller of lower microswitch of timer (S4) is in the cutout of cam No. 4. The switches are now in the position as shown on figure 4-1. When the power selector switch (S5) is set to the AUTO position, electrical power is applied through the 5-ampere fuse (F1), through POWER selector switch (S5) contacts 30 and 26 illuminating the POWER indicator lamp (DS2). Power is also applied through POWER selector switch (S5) contacts 27 and 31 energizing the timer motor and illuminating the TIMER indicator lamp (DS1). As the timer motor cams rotate, cam switches (S1, S3, S4) move to the right. Power is now applied through the top limit switch (S7), and cam switches (S3 and S1). Power applied through cam switch (S1) energizes the solenoid of the normally open brake valve (V1). This action releases air from the brake (the brake is now off). Power applied through cam switch (S3) energizes the solenoid of the normally closed raise valve (V3). This action allows air to enter the bottom of the pneumatic cylinder raising the carriage.

4-5. As the carriage rises the bottom limit switch (S6) moves to the right. The carriage guide lock trips and opens normally closed top limit switch (S7), de-energizing the solenoid of the normally closed raise valve (V3). This action cuts off the air supply to the bottom of the pneumatic cylinder. The remaining air exhausts through the quick exhaust valve. At the same instant the solenoid of the normally open brake valve (V1) is de-energized. This action allows air to enter the brake and holds the carriage in its raised position.

4-6. LOAD CYCLE. As the timer motor continues to rotate, cam switch (S2) moves to the right and the solenoid of the normally closed down valve (V2) is energized allowing air to flow into the top of the cylinder.

4-7. DOWN CYCLE. A few seconds after the load cycle, cam switch (S1) moves to the left. Power is now applied through S2, S6, and S1 to the solenoid of the brake valve (V1). This action releases the air from the brake housing allowing the carriage to be forced down by the air pressure built up in the top of the cylinder during the load cycle.

4-8. When the carriage guide block trips the bottom limit switch (S6), the switch opens (moves to the left) de-energizing the solenoid of the normally open brake valve (V1), thereby allowing air to enter the brake housing to provide braking action so as to prevent any secondary rebound.

4-9. A few seconds after impact, cam switch (S2) moves to the left de-energizing the solenoid of down valve (V2). This allows the air in the top of the cylinder to exhaust. Since the brake housing has been pressurized (paragraph 4-8) the carriage is held in place and eliminates any further bounce or secondary impact after the initial impact.

4-10. The timer motor cams continue to rotate and the sequence of operation of the shock test machine is repeated.

4-11. MANUAL OPERATION.

4-12. During the raise cycle, the switches are in the position as shown on figure 4-1. When the power selector switch (S5) is placed in the MAN position, electrical power is applied through the 5-ampere fuse (F1), through the power selector switch (S5) contacts 28 and 32 illuminating the POWER indicator lamp (DS2). To complete a raise, load and drop cycle of the test machine, the POWER selector switch pushbutton (S5) must be pressed and held down until the TIMER indicator lamp (DS1) stays illuminated. By depressing the pushbutton of S5, power is applied to the timer motor through contacts 27 and 31 of Switch 5. As the motor turns, switch (S4) moves to the right so that the pushbutton can be released since current now can flow to the timer motor and TIMER indicator lamp (DS1) through contacts 27 and 33 of the POWER selector switch (S5) and cam switch (S4). As the timer motor cams rotate, the cam switch (S4) stays in its closed position until it is opened when the microswitch roller falls into the cutout of cam No. 4. The raise, load and drop cycle is accomplished in the same sequence as described in automatic operation (paragraphs 4-4 through 4-9). At the completion of the drop cycle the POWER selector switch (S5) must again be pressed to complete additional cycle of the test machine.

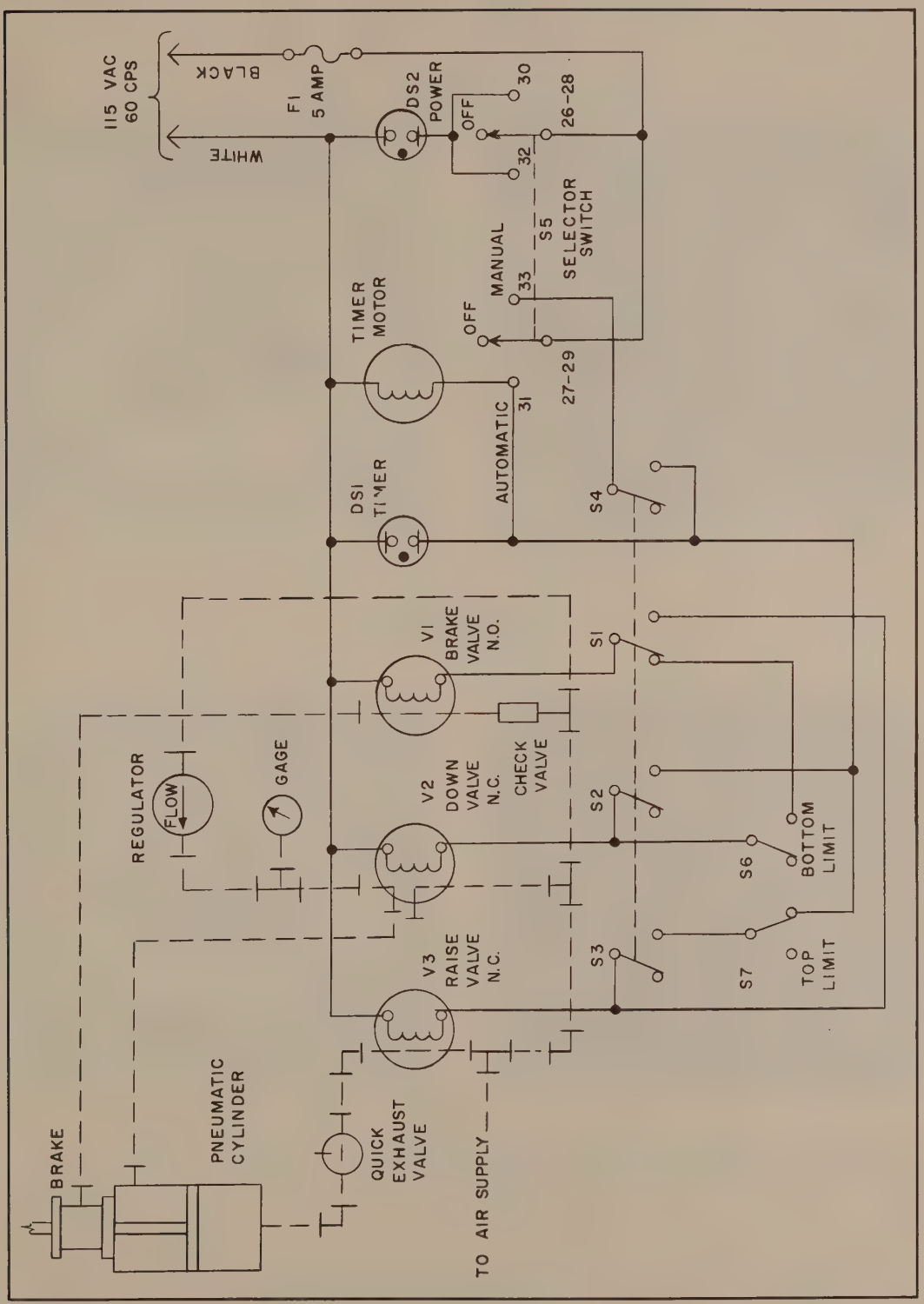

Figure 4-1. Electrical and Pneumatic System Schematic Diagram

4-13. DECELERATION DEVICES.

4-14. Shock pulses are obtained by the impact of the carriage assembly of the shock test machine against a deceleration device. These deceleration devices range in size, density and configuration from a solid-lead molded pellet, to hollow lead pellets, to solid rubber. The lead pellets rest freely on the anvil (figure 4-2); rubber pads are bonded to metal plates (figure 4-3) that bolt to the anvil.

4-15. When the desired size, weight shape, and material of a deceleration device is determined, additional devices may be fabricated by a simple molding process. Standard pads or pellet molds can be purchased from Avco. Special pulses require development and can be supplied to meet specific requirements.

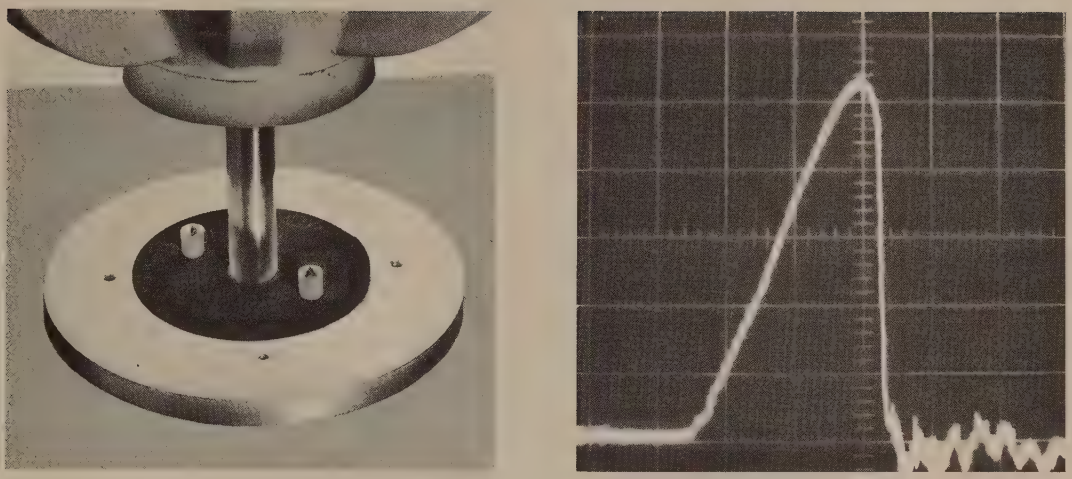

Figure 4-2. Lead Pellets on Anvil Plate and Resulting Sawtooth Shock Pulse

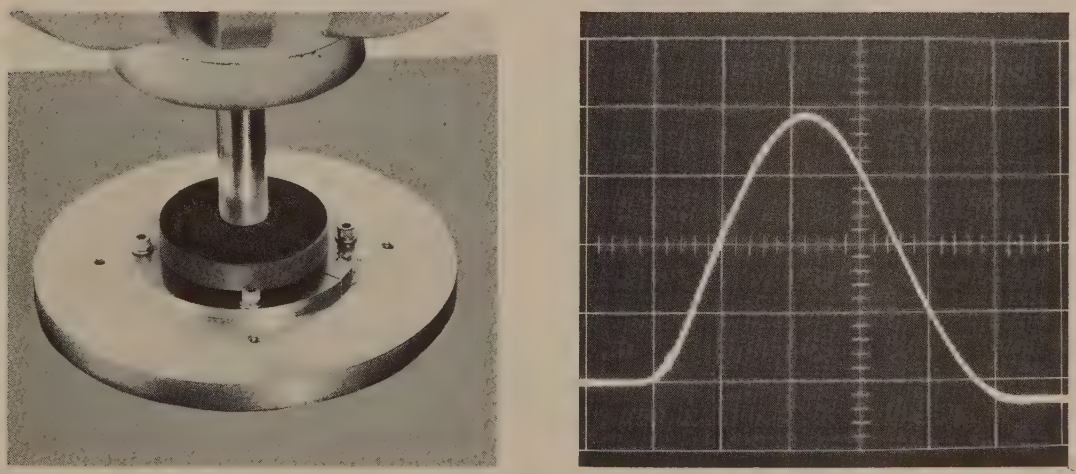

Figure 4-3. Rubber Pad and Resulting Half-Sine Shock Pulse

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. INSPECTION.

5-2. Inspect the subassemblies and components of the Shock Test Machine prior to use as outlined in Table 5-1.

Table 5-1. Inspection Chart

Component	Nature of Inspection
Guide Rod	Check for looseness
Limit Switches	Check for cracked cases, loose contact arm, and broken or frayed wires
Control Panel	Check for loose controls
Air Lines	Check all air lines for loose or damaged connections, cracks or other damage
Carriage	Check for looseness
Wiring	Check for loose connections and worn insulation

5-3. LUBRICATION.

5-4. The Shock Test Machine contains only one lubrication point, the pneumatic cylinder wall. Once every 3,000 cycles or once a week during use, whichever comes first, lubricate the shock machine as follows:

a. Disconnect the air line leading from the Raise Valve (V3) to the quick exhaust valve.

b. Place four or five drops of SAE No. 10 in the elbow and connect line to the elbow.

SECTION VI

TROUBLESHOOTING

6-1. GENERAL.

6-2. This section contains a troubleshooting table listing the symptom, probable cause, and remedy for repair of the Shock Test Machine and test instrumentation setup. For supplementary troubleshooting information refer to figure 6-1, Wiring Diagram of the Shock Test Machine.

6-3. TROUBLESHOOTING PROCEDURES.

6-4. When unsatisfactory operation or failure of the shock test machine is encountered, check the adjustment of the timer motor assembly first, as the timer assembly is the controlling component of the shock test machine.

6-5. ADJUSTMENT OF TIMER MOTOR ASSEMBLY CAMS.

6-6. The timer motor assembly is adjusted at the factory prior to its delivery. However, it may be necessary after extensive use of the machine to check its adjustment. To check the adjustment of the timer motor assembly, rotate the indicator knob on the bottom plate of the timer motor assembly until the adjustment holes in the cams are aligned with the hole in the timer motor bottom plate. The hole is located on the 75 position mark on the under side of the plate. Check the adjustment by inserting a 1/8-inch diameter rod through the adjustment hole and the holes in the cams. If a cam hole is not in line, position the cam so its alignment hole is in line with the holes in the other cams and the timer motor assembly bottom plate indicator hole.

NOTE

Adjustment of the cams can be easily accomplished by holding the black gear on the top end of the shaft with one hand and turning the cams into their proper position with the other hand. Each cam consists of two identical adjustable plates held in their respective positions by a friction washer. Both plates are fastened to a common hub that is secured to the shaft with two fillister head screws.

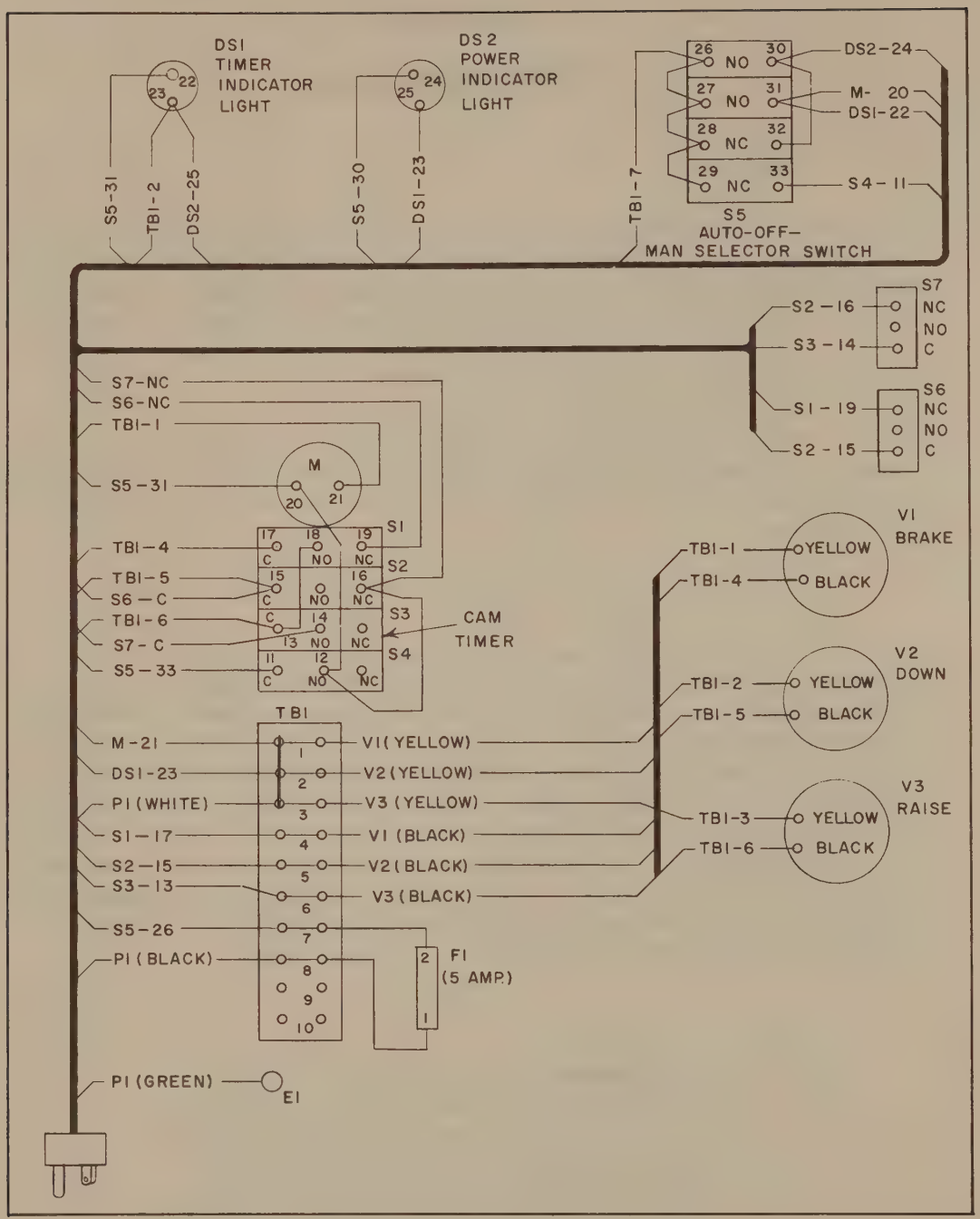

Figure 6-1. Wiring Diagram

Table 6-1. Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE	REMEDY
Carriage fails to raise	a. Power selector switch in OFF position.	a. Turn switch to ON.
	b. Defective fuse.	b. Replace fuse.
	c. Insufficient air pressure.	c. Adjust line pressure.
	d. Power line defective.	d. Replace power line.
	e. Selector switch defective.	e. Replace selector switch.
	f. Raise Valve V3 or exhaust valve defective.	f. Repair or replace defective raise valve V3 or exhaust valve.
	g. Top limit switch defective.	g. Replace limit switch.
	h. Malfunction of Timer (TM1).	h. Check operation, replace if necessary.
Carriage fails to drop.	a. Control Valve V2 defective.	a. Replace control valve V2.
	b. Automatic cycling not completed.	b. Refer to paragraph 6-5.
Carriage strikes anvil more than once.	a. Brake air line ruptured or leaking.	a. Replace brake air lines.
	b. Trigger switch too low.	b. Adjust height of trigger switch.

Table 6-1. Troubleshooting Chart (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
Brake fails to release	Valve VI is defective.	Replace valve VI.
Oscilloscope fails to function.	a. Instrumentation setup wired incorrectly.	a. Check wiring for shorts or disconnected terminals.
	b. Trigger switch too low.	b. Adjust trigger switch.
	c. Trigger switch not functioning properly.	c. Replace trigger switch.
	d. Instrumentation not functioning properly.	d. Troubleshoot instrumentation using manufacturer's recommendations.
	e. Trigger battery voltage too low.	e. Replace battery.
	f. Blocking capacitor of oscilloscope trigger circuit has not discharged.	f. Use a shunting resistor to discharge the blocking capacitor.
Spurious vibrations imposed on pulse.	a. Specimen loose on carriage.	a. Tighten specimen.
	b. Dirt between pad and anvil.	b. Remove pad and clean anvil and pad.
	c. Resonance within specimen.	c. No remedy.

Table 6-1. Troubleshooting Chart (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
Spurious vibrations imposed on pulse (cont)	d. Part of carriage assembly loose.	d. Tighten carriage assembly.
	e. Machine not located on solid footing.	e. Relocate the machine.
	f. Resonant frequency of accelerometer too low.	f. Use accelerometers with higher resonant frequencies.
	g. Rubber pads not properly tightened.	g. Tighten rubber pads.

SECTION VII

REPAIR INSTRUCTIONS

7-1. GENERAL.

7-2. This section contains the necessary instructions to perform repairs to the shock test machine. Refer to figures 7-1 through 7-5 at the end of the section, for location of parts. Table 7-1 lists the parts of the Type SM-005-2 Shock Test Machine.

7-3. REMOVAL AND INSTALLATION OF CARRIAGE ASSEMBLY.

7-4. REMOVAL.

a. Set REGULATOR knob on the control panel to zero as indicated on the pressure gage.

b. Place POWER selector switch in MAN position. Press POWER selector pushbutton. As soon as the carriage reaches the top limit switch, quickly turn selector switch to OFF position and remove power cable from power supply.

c. Remove the four screws securing the impact plate to the carriage and remove carriage and place in a clean working area.

7-5. CLEANING, INSPECTION, AND REPAIR.

a. Clean all parts thoroughly by wiping with a clean lint-free cloth dampened with a wax-free cleaning solvent (acetone).

b. Inspect the impact plate for cracks, chips, burrs, or excessive wear. Replace a damaged or worn impact plate.

7-6. INSTALLATION.

a. Install the carriage on the impact plate, and align the screw holes on the bottom of the carriage to the screw holes in the anvil plate. Install the four cap screws and secure the carriage to the impact plate.

CAUTION

Place lead pellets or a rubber pad on anvil plate.

b. Position POWER selector switch in MAN position, and press POWER selector switch pushbutton to return the carriage to its down position. Return POWER selector switch to OFF position.

7-7. REMOVAL AND INSTALLATION OF CONTROL PANEL AND GUIDE ROD.

7-8. REMOVAL.

a. Remove the carriage assembly as described in paragraph 7-4.

b. Loosen the thumbscrews securing the top-limit, bottom-limit, and trigger switches to the guide rod and remove the switch assemblies.

c. Remove the four acorn nuts and washers securing the control panel to the base assembly.

d. Remove selector switch and lights from panel.

e. Disconnect the air lines to the regulator, and remove the control panel from the base assembly.

f. Loosen the guide-rod locknut and remove the guide rod from the anvil plate.

7-9. CLEANING, INSPECTION, AND REPAIR. Follow the procedure as described in paragraph 7-5.

7-10. INSTALLATION

a. Install the guide rod with its keyway to the rear of the machine in the anvil plate and secure with the locknut.

b. Install the control panel on the base assembly and secure with the four acorn nuts and screws.

c. Connect the air lines to the regulator.

d. Install selector switch and panel lights.

e. Install the top-limit, bottom-limit, and trigger switches on the guide rod and tighten the thumbscrews.

f. Complete the installation by following the procedure described in paragraph 7-6.

7-11. REMOVAL AND INSTALLATION OF BRAKE CORE ASSEMBLY.

7-12. REMOVAL.

a. Remove the control panel and guide rod in accordance with the procedure described in paragraph 7-4.

b. Remove the control panel and guide rod in accordance with the instructions contained in paragraph 7-8.

c. Remove the eight capscrews and lockwashers securing the anvil plate to the base assembly.

d. Disconnect the air lines from bottom of the pneumatic cylinder.

e. Disconnect the air lines leading to the brake assembly and the down side of the piston in the pneumatic cylinder.

f. Remove the nipples from the brake housing and pneumatic cylinder.

g. Install two lifting eyes in the anvil plate 180 degrees apart.

h. Attach a lifting sling to the lifting eyes and lift the assembled anvil plate, brake assembly, and pneumatic cylinder from the base assembly manually or with a lifting device.

i. Place the assembly in a clean work area and disconnect the sling.

j. Remove the four capscrews securing the anvil plate to the brake housing and remove the anvil plate and anvil plate bushing.

k. Remove the four capscrews securing the brake housing to the pneumatic cylinder and remove the brake housing.

l. Push the brake core assembly from the brake housing.

7-13. CLEANING, INSPECTION, AND REPAIR.

a. Follow the procedure described in paragraph 7-5.

b. Inspect the core assembly for cracks, holes, loss of resiliency or other damage. Replace a defective core assembly.

c. Replace the two core assembly O-Rings.

7-14. INSTALLATION.

a. Properly position the O-rings on the core assembly and install the assembly in the brake housing.

b. Position the brake housing on the pneumatic cylinder making certain the air entry holes are aligned, and secure with the four capscrews.

c. Place the anvil plate bushing in the anvil plate and install the anvil plate with bushing over the piston-rod end onto the brake housing. Make certain the anvil plate foot is positioned 180 degrees away from the air entry hole in the brake housing, then secure the anvil plate to the brake housing with the four capscrews.

d. Attach a sling and suitable hoist to the lifting eyes in the anvil plate and properly position the assembled unit in the base assembly.

e. Remove the sling and lifting eyes from the anvil plate after making sure the foot of the anvil plate is facing the rear of the base assembly and all holes are aligned.

f. Install the eight lockwashers and capscrews that secure the anvil plate to the base assembly.

g. Install the nipples removed (paragraph 7-12) from the brake housing and pneumatic cylinder.

h. Connect the air lines leading to the brake assembly and the down side of the piston in the pneumatic cylinder.

i. Install the air line onto the bottom of the pneumatic cylinder by replacing the four screws in the quick exhuast valve after checking and cleaning the quick exhaust valve diaphragm.

j. Install the control panel and guide rod in accordance with the instructions contained in paragraph 7-10.

k. Install the carriage assembly in accordance with the procedure described in paragraph 7-6.

Table 7-1. Parts List for Type SM-005-2 Shock Test Machine

Figure No.	Index No.	Part No.	Nomenclature	No. Required
7-1	1	See fig. 7-2	Carriage Assembly	1
7-1	2	901195-1	Control Panel	1
7-1	3	901195-11	Pressure Gage	1
7-1	4	901195-13	AUTO-OFF-MAN Selector Power Switch	1
7-1	5	901195-15	POWER Indicator Light	1
7-1	6	901195-14	TIMER Indicator Light	1
7-1	7	901195-12	Pressure REGULATOR	1
7-1	8	SC3-5/16-24SS-24	Flat Head Screw 5/16-24UNC-3A X 1.50 lg cres.	4
7-1	9	See fig. 7-3	Brake and Cylinder Assembly	1
7-1	10	901198-1	Base Assembly	1
7-1	11	See fig. 7-5	Plate Assembly	1
7-1	12	FW5-1/4	Washer	4
7-1	13	NH7-1/4-20	Plain Hex Nut .250-20NC, stl cad pl	4
7-1	14	901217-1	Door	1
7-1	15	SM11-6-32 SC-5	Flat Heat Screw 6-32NC X .312 lg, stl cad pl	
7-1	16	901196-32	Fuse (F1) 250V-5 amp	
7-1	17	901188-34	Half Union	1

Table 7-1. Parts List for Type SM-005-2 Shock Test Machine (Cont)

Figure No.	Index No.	Part No.	Nomenclature	No. Required
7-1	18	901188-39	Nipple	1
7-1	19	901191-23	Elbow, .375 NPT Blk iron	1
7-1	20	LW5-3/8	Split Lock Washer .375 x .094 THK stl cad pl	8
7-1	21	SC1-3/8-16SC-28	Socket Head Cap Screw .375-16 UNC x 1.750 LG stl cad pl	8
7-1	22	NH7-3/4-16	NUT .750-16UNF-28	1
7-1	23	NH1-3/8-16	NUT .375-16UNC	4
7-1	24	FW2-3/8	Flat Washer .4061D x .062THK CRES	8
7-1	25	NA3-3/8-16	Acorn Nut .375-16 UNC x .625 HIGH CRES	4
7-1	26	See figure 7-4	Limit Switches and Trigger Switch with Guide Rod	1
7-2	27	SH1-5/16-SC-32	Socket Hex Head Shoulder Screw THD-1/4-20 UNC-3A x 7/16 LG Shoulder 5/16 DIA x 2.000 LG STD	2
7-2	28	901205-1	Carriage Guide	1
7-2	29	900848-1	Carriage	1
7-2	30	901192-1	Impact Plate (Part of brake and cylinder assembly)	1

Table 7-1. Parts List for Type SM-005-2 Shock Test Machine (Cont)

Figure No.	Index No.	Part No.	Nomenclature	No. Required
7-2	31	SC3-5/16-24-SS-24	Flat Head Screw 5/16-24UNC-3A x 1.500 lg cres	4 4
7-3	32	SC1-5/8-11SX-16	Socket Head Screw .625-11NC-3A x 1.00 lg, stl cad pl	1
7-3	33	LW5-5/8	Split Lock Washer .625ID x .161 THK, stl cad pl	1
7-3	34	901192-1	Impact Plate	1
7-3	35	900849-1	Anvil Plate	1
7-3	36	900843-1	Bushing	1
7-3	37	901191-21	O-Ring	2
7-3	38	900857-1	Brake Housing	1
7-3	39	LW5-5/16	Plain Washer .3121D x .078 THK stl	4
7-3	40	SCI-5/16-18SX-16	Socket Head Capscrew .312-18UNC-3A x 1.00 lg stl	4
7-3	41	901191-22	Nipple .375 NPT x 1.50 lg stl	1
7-3	42	901191-23	Elbow .375 NPT BLK IRON	1
7-3	43	901190-1	Pneumatic Cylinder	1
7-3	44	SCL-5/16-18SX-24	Socket Head Capscrew .312-18 NC x 1.50 lg stl	4
7-3	45	LW5-5/16	Plain Washer .312 ID x .078 THK stl	4

Table 7-1. Parts List for Type SM-005-2 Shock Test Machine (Cont)

Figure No.	Index No.	Part No.	Nomenclature	No. Required
7-3	46	900850-1	Core Assembly	1
7-3	47	SC3-5/16-24SS-24	Flat Head Screw 5/16-24UNC-3A x 1.50 lg cres	4
7-4	48	900851-1	Guide Rod	1
7-4	49	901188-37	Switch Cover	3
7-4	50	901311-1	Microswitch	3
7-4	51	901204-1	Adjustment Arm	
7-4	52	FW5 No. 6	Flat Washer .156 ID x .065 THK stl cad pl	6
7-4	53	SM12-6-32-SC-16	Round Head Screw 6-32 NC x 1.000 lg. stl cad pl	6
7-4	54	SM14-10-24SC-8	Fillister Head Screw 10-24 NC x .500 lg. stl cad pl	4
7-4	55	FW5 No. 10	Flat Washer .203 ID x .065 THK stl cad pl	4
7-4	56	NH 7-3/4-16	Nut .750-16 UNF-28	1
7-4	57	901203-1	Bracket	1
7-4	58	901188-41	Thumb Screw .250 -20 x 1.25 lg	2
7-4	59	901206-1	Bracket	1
7-5	60	901196-17	Plastic Tubing (Typical)	as required

Table 7-1. Parts List for Type SM-005-2 Shock Test Machine (Cont)

Figure No.	Index No.	Part No.	Nomenclature	No. Required
7-5	61	901196-47	Typical Nut Supplied with each fitting	as required
7-5	62	901196-46	Typical sleeve supplied with each fitting	as required
7-5	63	901196-29	Tee	1
7-5	64	901196-43	Check Valve	1
7-5	65	901196-39	Hex Nipple	2
7-5	66	901196-37	Brake Valve (V1)	1
7-5	67	901196-30	Elbow	4
7-5	68	901196-36	Down Valve (V2)	1
7-5	69	901213-1	Tee	1
7-5	70	901196-34	Elbow	1
7-5	71	901107-7	Nipple, Orifice	1
7-5	72	LW4-10	Washer	14
7-5	73	SM12-10-24 SC-5	Screw 10-24NC-2A x .312 lg stl cad pl	14
7-5	74	901196-35	Raise Valve (V3)	1
7-5	75	901196-38	Tee	1
7-5	76	901214-1	Cam Timer Assembly	1
7-5	77	901212-1	Cam No. 1	1
7-5	78	901212-2	Cam No. 2	1
7-5	79	901212-3	Cam No. 3	1
7-5	80	901212-4	Cam No. 4	1

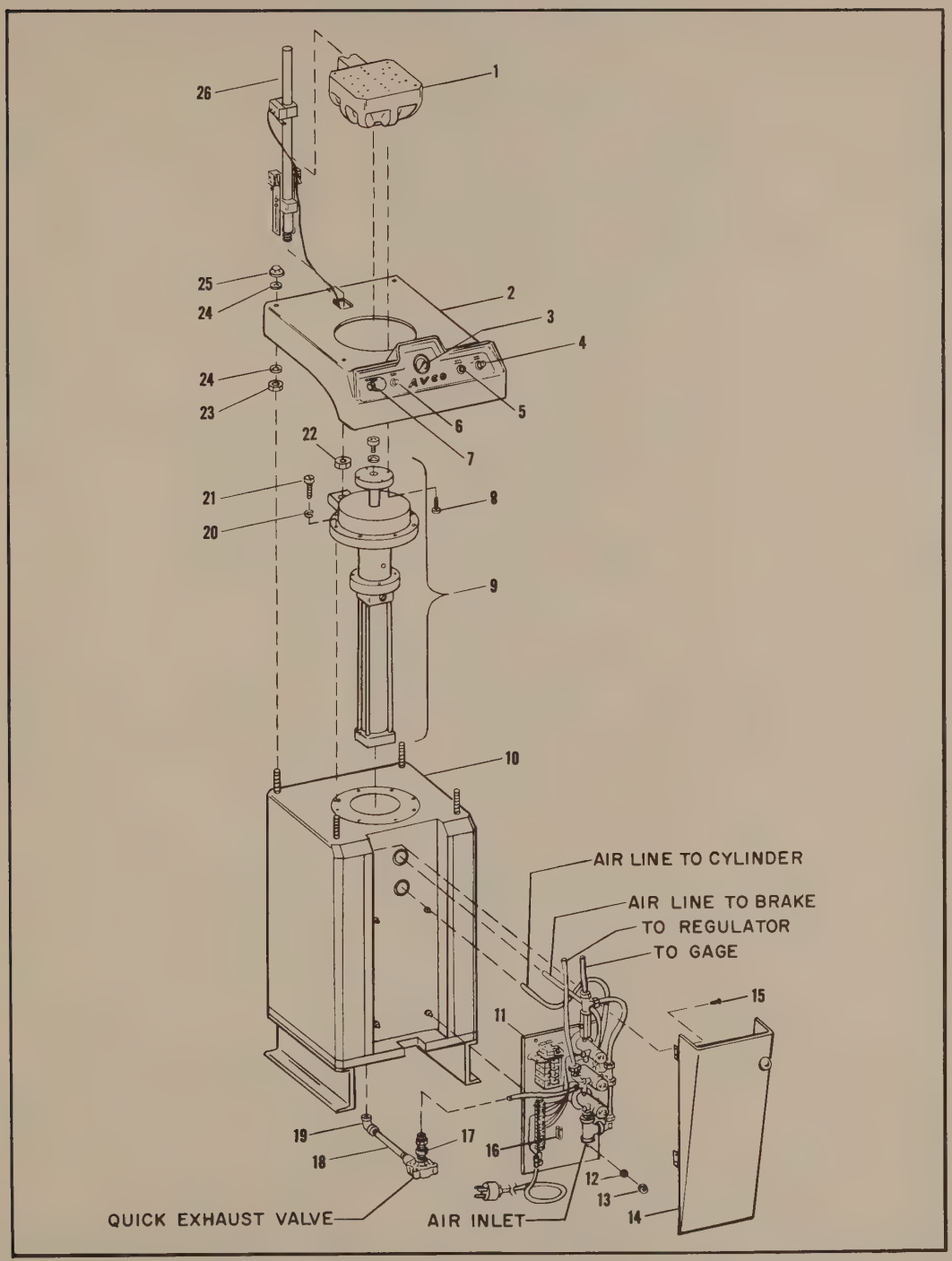

Figure 7-1. Avco Shock Test Machine, Exploded View

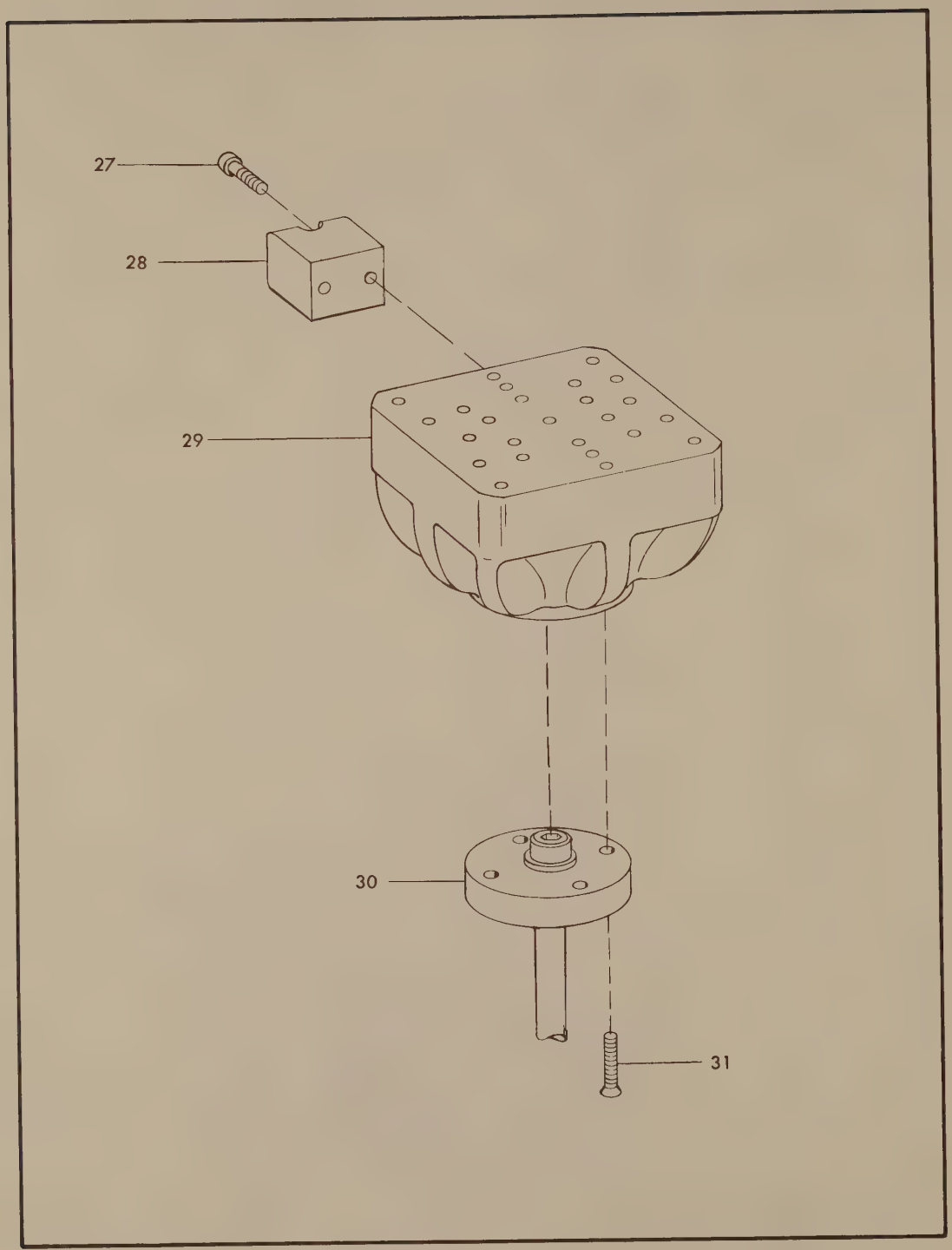

Figure 7-2. Carriage Assembly, Exploded View

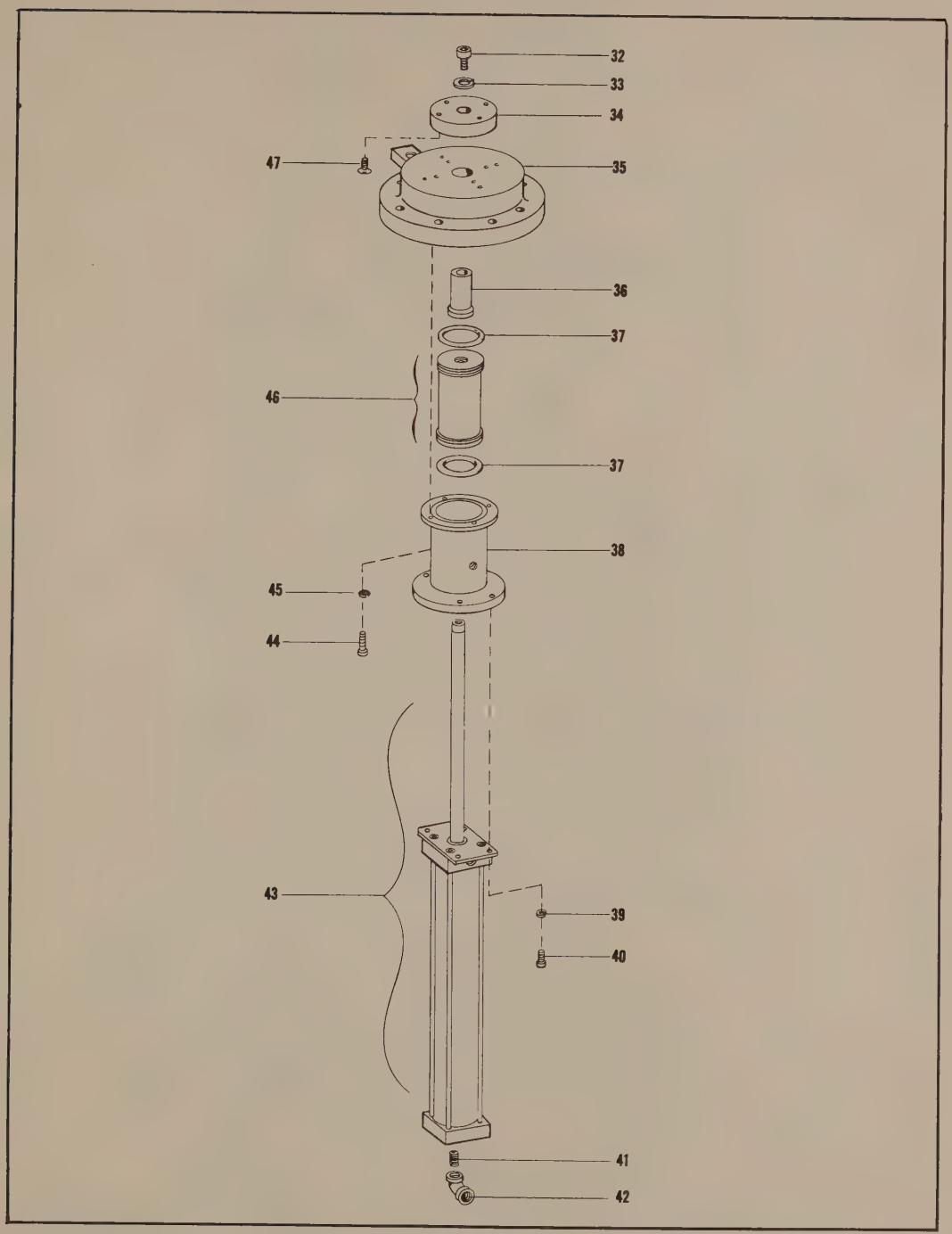

Figure 7-3. Brake and Cylinder Assembly, Exploded View

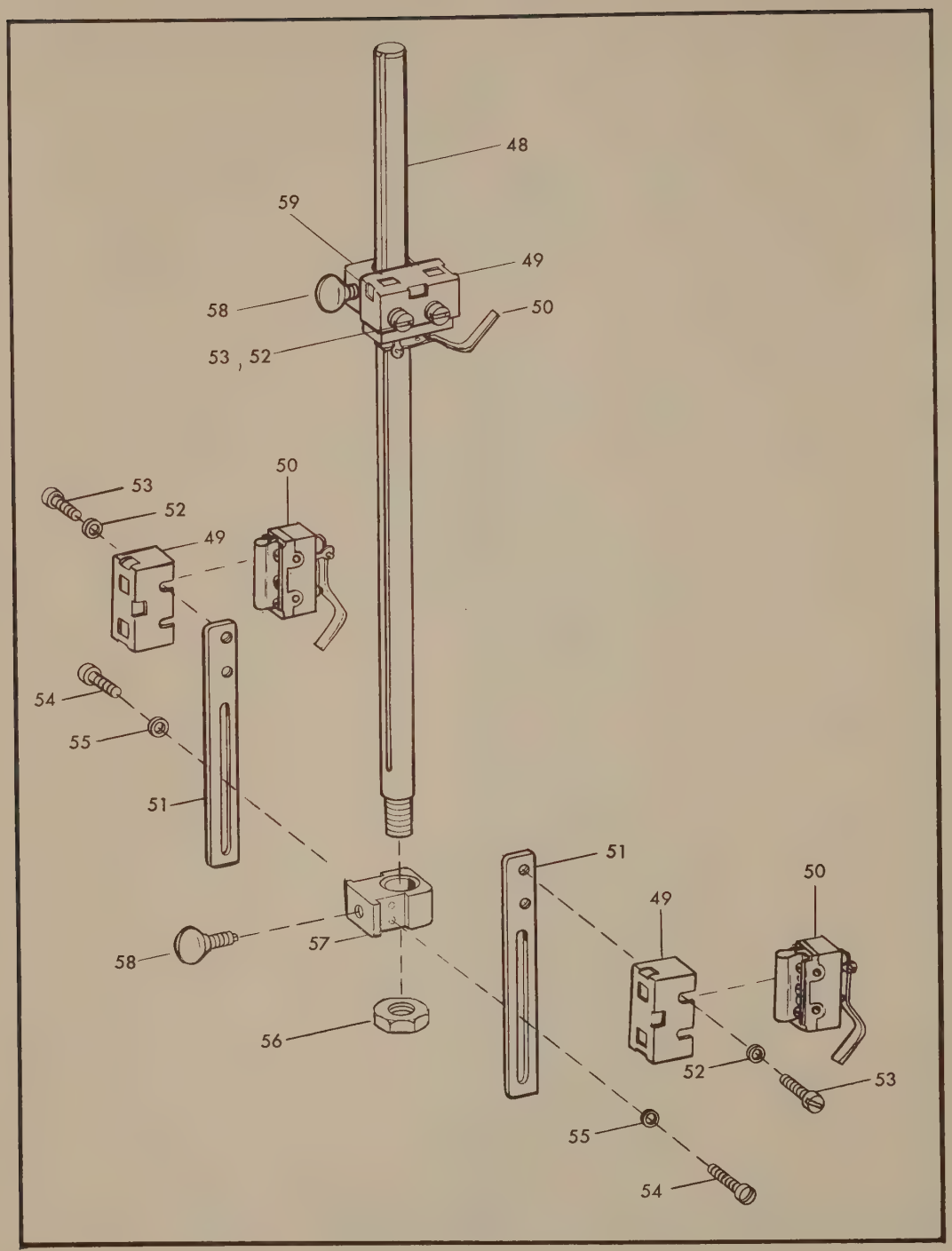

Figure 7-4. Limit Switches and Trigger Switch, with Guide Rod

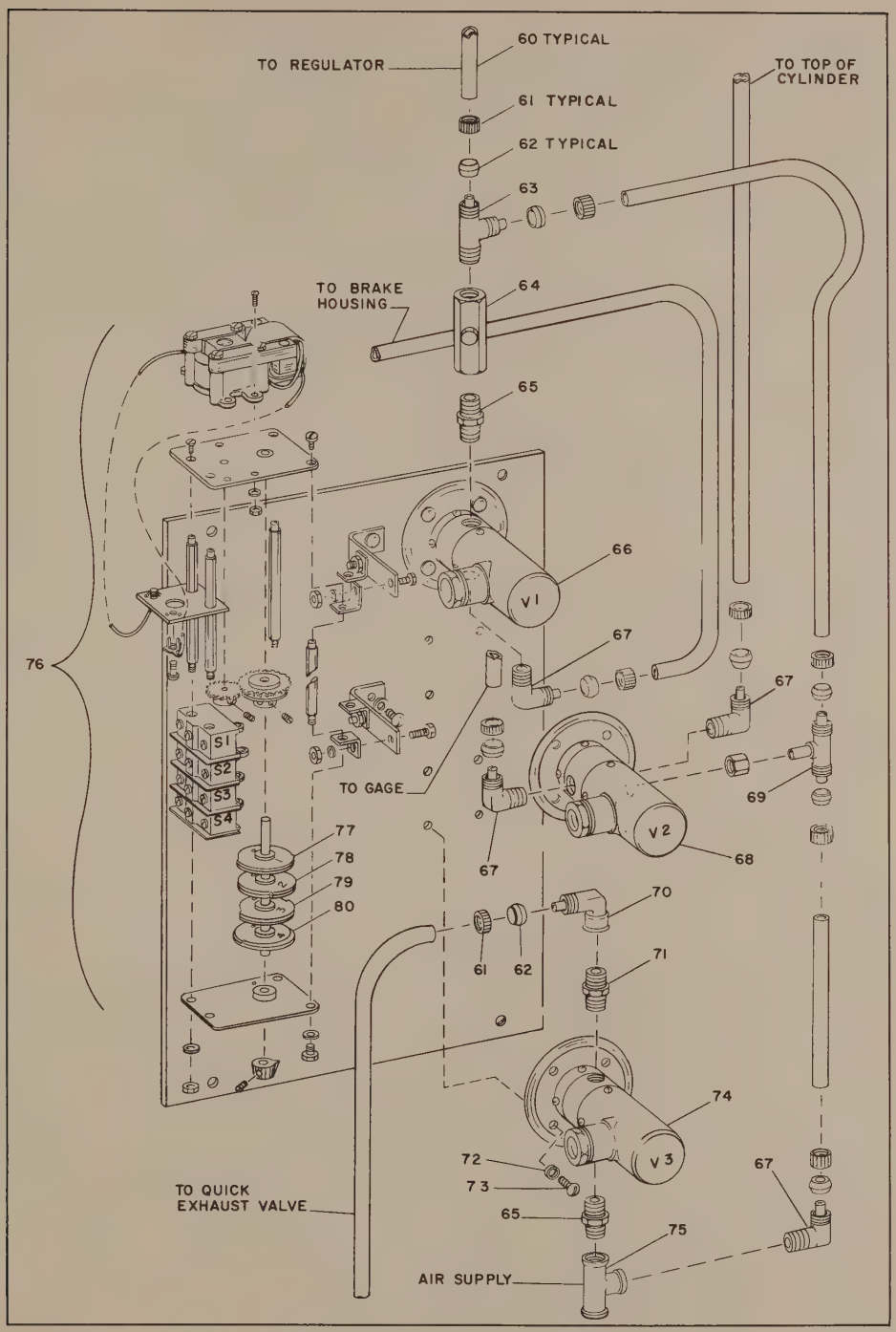

Figure 7-5. Plate Assembly, Exploded View

WARRANTY

Avco Research and Advanced Development Division (Avco RAD) warrants its products to be free of defects in materials and workmanship for a period of six (6) months after shipment from its plant; or in the case of equipment requiring checkout by an authorized representative of Avco RAD, warranty shall be six (6) months from date of checkout, but in any case, will expire one (1) year from date of shipment. This warranty does not cover the Avco RAD product unless it is properly installed, maintained, and used under normal environmental conditions in accordance with current instructions and manuals of Avco RAD.

Such Warranty is limited to replacement or repair by RAD of any part or parts which have been returned to RAD and which, in its opinion, are defective (except that commercial parts purchased by Avco RAD and installed in the equipment will carry original Manufacturers Warranty only) provided that transportation charges and any and all sales taxes, duties, imposts or excises for such part or parts shall be paid for by the Buyer. Repaired parts or replacement parts, installed in fulfillment of these warranties, are warranted only ior the unexpired portion of the original warranty. Avco RAD shall have the sole right to determine whether defective parts shall be repaired or replaced.

Such Warranty does not cover any customer labor charges for replacement of parts, adjustments, or repairs, or any other work unless such charges be authorized in advance in writing by Avco RAD. Avco RAD service required due solely to defects in materials or workmanship will be supplied free of charge except that all transportation incurred during such service will be paid for by the customer. This said Warranty is expressly in lieu of any and all other warranties or representations, expressed or implied, and of any other obligations or liabilities of Avco RAD to the Buyer arising out of the use of the said product, and no agreement or understanding varying or extending the same will be binding upon Avco RAD, unless in writing, signed by a duly authorized officer or representative. The said Warranty shall not apply to any product which, in the judgment of Avco RAD, shall have been subject to misuse or neglect, or shall have been repaired or altered outside the Avco RAD plant in any way which may have impaired its safety, operation, or efficienty, nor to any product which has been subject to accident. The said Warranty shall not apply if any part not manufactured or supplied by Avco RAD for use in the operation thereof shall have been substituted and used in place of the part manufactured or supplied by RAD for such use.

Avco RAD reserves the right to make changes in design or additions to or improvements in its product at any time without imposing any liability on itself to install the same in any product manufactured prior thereto.

All shock pads and pellet molds are warranted only for a period of ninety days after shipment.

Industrial Products Subdivision
AVCO CORPORATION
Wilmington, Massachusetts

Printed in USA

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